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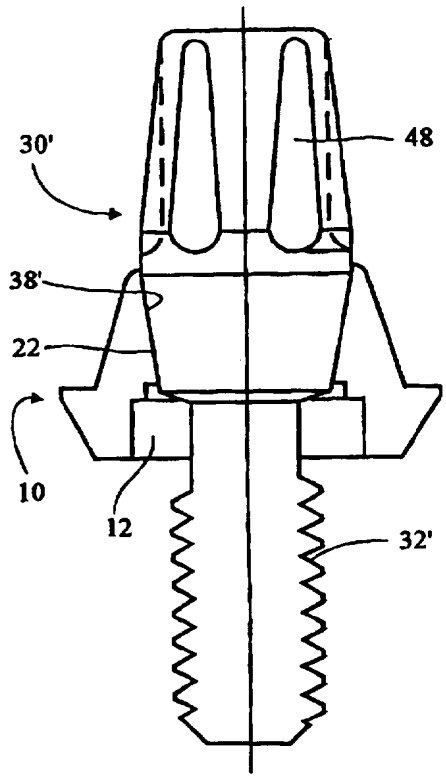
(54) Title: TWO-PIECE DENTAL ABUTMENT

(57) Abstract

A two-piece abutment system is disclosed. The first part (10) includes a tapering inner surface (22) which is part of a bore extending entirely through the first part (10). The first part (10) includes a socket (12) for mating with a boss or post (134) on a dental implant (130). The elongated second part (30) includes a threaded stem (32) for engaging a threaded bore (136) with a dental implant (130) and a post (34) which extends above the first part (10). The second part (30) extends through the bore of the first part (10) and is screwed into the implant (130). As the second part (30) is screwed into the implant (130), a tapering external surface (38) on the post (34) of the second part (30) frictionally locks with the tapering inner surface (22) of the first part (10).



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TWO-PIECE DENTAL ABUTMENT

BACKGROUND OF THE INVENTION

This specification describes, with references to the accompanying drawings, an improvement in abutments used to attach dental restorations to artificial dental roots such as dental implants. The illustrated abutment has a generally tubular first part which can be fitted through overlying gum tissue and attached non-rotationally to a dental implant. The first part provides a through-passage to a receiving bore in the implant. A second part of the abutment has an attaching stem extending through the through-passage of the first part into the receiving bore and a post protruding supragingivally through the first part from the stem. The post of the second part and the first part have respective male and female interfitting locking tapers which serve to frictionally lock the second part against turning in the first part when the stem is properly engaged in the receiving bore. Typically, the receiving bore is internally threaded and the stem is externally threaded so as to screw into the receiving bore. In use, the first part is fitted onto the implant and the threaded stem of the second part is screwed into the receiving bore until the male locking taper of the second part engages tightly in the female locking taper of the first part. In this way, the two-piece abutment is effectively attached non-rotationally to the implant.

The post of the second part may be configured to serve other functions in the dental restoration process. For example, the post may have flat side that allows it to serve as an impression coping. Additionally, the post may have means for fastening other components thereon. For example, a healing cap that encompasses the post may be attached to the post. Alternatively, an impression coping may be attached thereon. Lastly, the post may serve as a structure for supporting both a temporary or permanent dentition.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 shows a first part of the two-piece abutment in longitudinal cross-section;

FIG. 2 is a side view of a second part of the two-piece abutment;

FIG. 3 is a side view of an alternative second part having a longer post;

FIG. 4 is a side view of an assembly of a second part having flutes along the post and the first part of FIG. 1;

FIG. 5 is an end view of FIG. 4;

FIG. 6 is a side view of an assembly having a longer second part with flutes and the first part of FIG. 1;

FIGS. 7A-7C illustrate an alternative first part which has a cylindrical outer surface;

FIGS. 8A-8B illustrate an alternative second part having a flattened side on its post;

FIGS. 9A-9B illustrate an alternative second part having a threaded bore in its post;

FIGS. 10A-10C illustrate alternative first parts in which the exterior surface is non-round;

FIGS. 11A-11B illustrate the assembly of the first part of FIG. 7 and the second part of FIG. 9 mounted on an implant;

FIG. 12 illustrates the assembly of FIG. 11 with an impression coping attached to the post;

FIG. 13 illustrates the assembly of FIG. 11 with a healing cap attached to the post;

FIG. 14 illustrates the assembly of FIG. 11 with a prosthetic tooth mounted on a gold cylinder that is attached to the post;

FIG. 15 illustrates a two-piece assembly with a prosthetic tooth directly attached to the post; and

FIGS. 16a-16f illustrate the first part of the two-piece abutment having anti-rotational connecting structures in the socket region.

DETAILED DESCRIPTION OF THE DRAWINGS

The first part 10 shown in FIG. 1 comprises a tubular body 11 having a socket 12 at its lower section 14. The socket 12 extends upwardly into the body 11 from its lower wall 16 and has a regular polygonal (hexagonal) transverse shape for interfitting non-rotationally on a matching boss of a typical dental implant (illustrated in FIGS. 11-15). Externally, the lower section 14 of the body 11 has an expanding transverse size as it proceeds away from the lower wall 16 and an upper section 18 of contracting transverse size as it proceeds further away from the lower wall 16. Where the lower and uppers sections 14 and 18 are joined, the upper section 18 is smaller transversely than the lower section 14 which provides for a shoulder 20 facing away from the implant. The upper section has a female locking taper 22 which opens into the socket 12. The female locking taper 22 and the socket 12 form a part of a bore through the first part 10. The female locking taper 22 diverges at an angle α which is generally in the range from about 5° to about 20°.

The second part 30 shown in FIG. 2 has a threaded stem 32 and a post 34 which is in three sections. A first section 36 has a male locking taper 38 matching the female locking taper 22 of the first part 10. Thus, angle α in the first section 36 is the same as angle α in the female locking taper 22 of the first part 10. An intermediate section 40 is generally cylindrical. A third section 42 has a contracting transverse section and tapers inwardly at an angle β which is typically in the range from about 5° to about 30°. The size of the post 34 may vary based on the patient and the function for which the second part 30 is used. For example, a second part 44 in FIG. 3 has a post with a longer intermediate section 46.

As can be seen in FIG. 4, the post extends above the first part 10 by an amount at least as large as the height of the first part 10. In some cases, as is shown in FIG. 6, the post extends above the first part 10 by an amount roughly the same as the length of the second part below the upper edge of the first part 10.

FIGS. 4-5 illustrate a second part 30' which is similar in size and shape to the second part 30 of FIG. 2. However, second part 30' includes a plurality of flutes 48 where a tool (not shown) can engage and rotate the second part 30' into the first part

10 as the threaded stem 32' is screwed into a threaded bore of an implant. When the two parts 10 and 30' are assembled, as shown in FIG. 4, the locking tapers 22 and 38' engage to frictionally lock the two parts 10 and 30' against relative rotation. With the stem 32' screwed into an implant and the socket 12 non-rotationally engaged on the implant, the two-piece abutment of the invention is non-rotationally fixed to the implant.

FIG. 6 shows a longer second part 44' that is similar to the second part 44 which has a larger post and engages the first part 10 (FIG. 3). The male locking tapers of both second parts 44' and 30' (FIG. 4) are interchangeably the same such that both second parts 44' and 30' may be used with the same first part 10. Similarly, first parts of different external configurations may be provided as is evident in FIGS. 7 and 10 below. It will be understood that the interchangeability of components in this invention lends itself to providing components in sets that may be adapted to various dental restoration tasks depending on the needs of a particular patient. Once the two parts 10 and 30 are in their final position on the implant, the clinician can then prepare the post 34 such that it conforms to the precise height and angle of the adjacent teeth. The clinician performs this task by cutting into the surface of the post 34. In essence, the two-piece abutment system can be used in its manufactured configuration or adjusted to a unique configuration that is suited for a particular patient.

FIGS. 7A-7C illustrate an alternative first part 60 which has a body 61 with a substantially cylindrical outer surface 62. A bore 64 extends through the body 61 and includes a socket region 66. The socket region 66 is polygonal (hexagonal in this case) and includes an anti-rotational structure 68 in each of its six corners 70. These anti-rotational structures 68 are discussed in detail below with reference to FIGS. 16a-16f.

The bore 64 also includes a locking taper region 72 and an intermediate region 74. The locking taper region 72 engages a correspondingly shaped male taper on a post of a second part of the two-piece abutment like second parts shown in FIGS. 8-9. The angle of the taper is typically the same as the range given for angle α in FIG. 1. Moreover, the style of the first part 10 in FIGS 1-6 and the style of the first part 60 in

FIGS. 7A-7C may be in the same dental kit such that the clinician chooses the style that is best suited for his or her patient. Preferably, the internal taper angle is the same for the first parts 10 and 60 so that same type of second part can be utilized. Additionally, a dental set may include not only different styles, but it may include different sizes of each style.

The first part 60 includes a bottom surface 76 which is adjacent the socket region 66 and engages the implant. At the other end of the first part 60, a shoulder 78 resides which provides for a surface against which another component may abut. An externally tapered region 80 is at the extremity of the first part 60.

FIGS. 8A and 8B illustrate a second part 90 that is compatible with the first part 60 in FIGS. 7A-7C. The second part 90 includes a threaded shaft 92 which mates with an internally threaded bore of the implant. A male tapered portion 94 is adjacent the threaded shaft 92 and matches the locking taper region 74 of the first part 60. An intermediate portion 95 is adjacent the tapered portion 94 and is generally cylindrical. Lastly, an upper portion 96 that reduces in cross section is located at the extremity of the second part 90. As is seen only in FIG. 8B, the upper portion 96 has a flattened surface 98 which provides for a surface to grip when rotating the second part 90. The flattened surface 98 also provides for the non-rotational mating with another component encompassing upper portion 96 assuming that component includes a flat interior surface that engages the flattened surface 98.

FIGS. 9A-9B illustrate an alternative second part 100 which differs from the second part 90 in FIGS. 8A-8B only in that it contains a threaded bore 101 in its upper portion 106. The threaded bore 101 is used to attach other components to the second part 100 as will be shown in FIGS. 12-15. Thus, the threaded shaft 102, the male tapered portion 104, the intermediate portion 105, and the flattened surface 108 on the upper portion 106 are the same structures that are present on the second part 90 in FIGS. 8A-8B.

FIGS. 10A-10C illustrate yet other alternative first parts. FIGS. 10A and 10B illustrate a non-round shape to a first part 110. The body 111 has an outer surface 112 that is non-round initially but then gradually changes to round in a tapered section

114 adjacent the socket 116. Thus, the bottom surface 118 is round to mate with a cylindrical implant. By utilizing a non-round shape, the gingiva above the implant can be formed and maintained in the shape that natural tooth had in that region. Consequently, a more aesthetically pleasing prosthesis can be developed since it will emerge from the gingiva in the same contour as the natural tooth did.

FIG. 10C illustrates a first part 120 which deviates from the first part 110 of FIGS. 10A-10B in two ways. First, an oval shape is present on an exterior surface 122 of the first part 120. This oval shape also gradually changes to a round shape at the lower surface 124 so as to mate with a cylindrical implant. And, a socket 126 is present that includes the shape of a twelve-pointed star that allows the first part 120 to be mounted on the hexagonal boss of an implant in twelve orientations. It should be noted that the internal structure of the first parts 110 and 120 of FIGS. 10A-10C is the same as the previously described first parts so as to be interchangeable those devices. Expanding the dental kit to include non-round shapes offers more options to the clinician and allows him or her to select a first part that is best suited for the patient.

FIGS. 11A-11B illustrate the first part 60 of FIG. 7 and the second part 100 of FIG. 9 mounted on an implant 130. The implant 130 has an upper table 132 on which the lower surface 76 of the first part 60 mates. The socket 66 of the first part 60 captures the correspondingly shaped boss 134 on the implant 130. As the threaded shaft 102 of the second part 100 is screwed into a threaded bore 136 in the implant 130, the locking tapered surfaces 104 and 72 engage and tighten. Typically, the torque required to complete the assembly of the first and second parts 60 and 100 on the implant 120 is in the range from about 30 N•cm to about 40 N•cm. Once assembled, the two-piece abutment serves numerous functions as is described below.

FIG. 12 illustrates an impression coping 140 fixed on the second part 100. The impression coping 140 has a bottom surface 142 which engages the shoulder 78 of the first part 60. The interior surface of the impression coping 140 has a contour that matches the contour of the exterior surface of the second part 100. Thus, the interior surface has a flat region 143 to match the external flattened surface 108 of the second part 100 to resist rotation therearound. The impression coping 140 also

includes a wide-head screw 144 which threadably engages threaded bore 101 and holds the impression coping 140 on the second part 100. The impression coping 140 includes an external flat side 146 which allows for the impression coping 140 to be properly realigned within the impression material after the impression is made. Instead of one flat side 146, the coping 140 can have several surfaces for non-rotationally engaging the impression material. As shown, the impression coping 140 is a transfer coping in that after the impression is taken, the impression material is removed without the coping 140 be carried with it. The screw 144 is removed and coping 140 is "transferred" back into the impression material with the flat surface 146 being aligned with the flat surface within the cavity of the impression material. The coping 140 is then mounted on an analog of the implant 130 and the first and second parts 60 and 10 and a model of the region is made.

Alternatively, the screw 144 could be elongated with a head that extends above the impression material. After the impression material has been placed at the site, the elongated screw, which is exposed through the impression material, is unscrewed. The coping 140 would then be retained within, or "picked-up" by, the impression material when it is removed from the site. Thus, the impression coping 140 could also be used as a pick-up type impression coping.

Furthermore, the second part 100 with its flat surface 108 could itself be used as an impression coping. That is to say that the impression material can be placed directly over the second part 100. Then, after the impression material is removed, an angular registering mark is placed between the first part 60 and the second part 100 to ensure that they are realigned exactly on an implant analog when making the model to develop a permanent dentition. While the first and second parts 60 and 100 are removed, a temporary abutment could be placed on the implant. Alternatively, a second set of the first and second parts 60 and 100 having a healing cap (FIG. 13) or a temporary dentition (FIG. 15) could be placed on the implant until the original set is returned with a permanent dentition attached.

FIG. 13 illustrates a healing cap 150 that is placed over the second part 100. The healing cap 150 is held on the second part 100 by a screw 152 that threadably

engages the threaded hole 101. The screw 152 is approximately flush with the upper surface of the healing cap 150. The healing cap 150 has a lower surface 154 which engages the shoulder 78 of the first part 60. The interior surface of the healing cap 150 includes a flat portion 156 that engages the flattened side 108 of the second part 100 to resist rotation of the healing cap 150 around the second part 100.

FIG. 14 illustrates a cylinder 160 on which a prosthetic tooth 162 is permanently mounted. The prosthetic tooth 162 has a hole 164 at its upper end allowing a screw 166 to pass therethrough and connect the cylinder 160 to the second part 100 via the threaded bore 101. The cylinder 160 has a lower surface 168 which abuts the shoulder 78 of the first part 60. The interior surface of the cylinder 160 has a flat surface 170 that engages the flattened surface 108 of the second part 100. Thus, the cylinder 160 cannot rotate on the second part 100. Alternatively, the lower region of the cylinder 160 adjacent to the lower surface 168 could have a series of flats that could mate with a series of flats on the externally tapered region 80 of the first part 60 for resisting rotation.

FIG. 15 illustrates the second part 90 of FIGS. 8A-8B mounted on the first part 60. The surface of the second part 90 has been prepared to receive cement and connect the second part 90 to an artificial tooth 180. The artificial tooth 180 may be made of an acrylic such that the clinician can modify it to fit precisely in the patient's mouth. The artificial tooth 180 can be a permanent tooth, or it may be attached to the second part 90 via a temporary cement such that it is a temporary dentition.

FIG. 16a is a detailed view of the first part 60 showing the corners 70 and the anti-rotational structures 68 placed thereon. Because of the tolerances in the boss of the implant and the socket, these two-pieces never fit tightly within each other. Therefore, there is always a slight rotation between the parts. Typically, when a screw holds down an abutment, the torque is used to produce tension in the screw as its threads engage the implant. In the present invention, the torque on the second part is resisted by the friction at the engaged locking tapers of the first and second parts and by the tension produced by the engaging threads. Thus, the tension in the second part is typically less (because of the friction at the locking tapers that the torque

overcomes) which increases the likelihood that the first part may loosen on the implant. One option is to decrease the cross-sectional area of the second part at a neck which increases the stress and increases the strain to hold the pieces tightly together. The second part 30 in FIG. 2 has such a neck between the threaded stem 32 and the male locking taper 38.

Alternatively, anti-rotational structures 68 can be used that make contact with sidewalls of the hexagonal boss of the implant at its corners to prevent rotation of the implant in the socket 66. These anti-rotational structures 68, as shown in FIG. 16a, are essentially shims located at the corners 70. Alternatively, the anti-rotational structures 68 can be removed somewhat from the corners 70, as is shown in FIG. 16b. Thus, they do not have to be located directly in the corners 70.

FIG. 16c illustrates the anti-rotational structures 68 being a corner block as opposed to being shims. The corner blocks come into firm contact with the hexagonal boss of the implant at the corners of the implants. The corner blocks are dimensioned so that opposite pairs of the blocks will squeeze the hexagonal boss between them to hold the first part 60 tightly on the implant.

FIG. 16d shows anti-rotational structures 68 at the corners 70 which have the squeezing effect from the corner blocks as described above with reference to FIG. 16c. Additionally, the anti-rotational structures 68 have a shim-type structure which enhances the contact of anti-rotational structures 68 with the sides of the boss of the implant.

FIG. 16e shows an anti-rotational structure 68 in still another embodiment. Here, a corner block is in the corner 70 and shims are positioned outside the corner.

FIG. 16f shows a preferred embodiment of the invention which includes modified anti-rotational structures 68 to facilitate a smooth entrance of the hexagonal boss into the socket while still providing an anti-rotational effect. The improvement can best be observed by comparing the anti-rotational structures shown in FIG. 16f to those shown in FIG. 16a. Referring to FIG. 16a, it is noted that the corner anti-rotational structures 68 have upper edges which are substantially parallel to and spaced below the upper edge of the socket. Upon initial insertion and until

encountering the upper edge of the corner anti-rotational structures 68, the hexagonal boss fits within the socket with the same degree of rotational looseness as encountered in the prior art. As the boss of the implant is inserted further into the socket, it encounters an abrupt "tightening" of fit along the upper edge of the corner anti-rotational structures 68. The embodiment shown in FIG. 16f facilitates entry of the boss into the socket by angling the upper edges of each corner shim pair relative to the upper edge of the socket. Specifically, the top edges of each shim pair are angled toward each other and toward the upper edge of the socket so that they meet at an apex near the upper end of a corner of the socket. As the boss is inserted into the socket, it initially encounters the same degree of rotational looseness as in the prior art, but quickly reaches the apexes of the angled shim pairs. As the boss of the implant penetrates further into the socket, the sidewalls of the boss contact the ends of the angled upper edges of the anti-rotational structures nearest the corners of the socket. Then, as the boss is further inserted into the socket, the sidewalls gradually come into contact with progressively increasing surface areas of the anti-rotational structures until the anti-rotational structures are in full contact with the boss and achieve the full anti-rotational effect. It may be noted that while the improvement of FIG.16f has been described in relation to FIG. 16a, the same type of improvement may be achieved by angling the upper edges of the anti-rotational structures 68 in other embodiments such as those shown in FIGS. 16b, 16d, and 16e.

While the present invention has been described with reference to one or more particular embodiments, those skilled in the art will recognize that many changes may be made thereto without departing from the spirit and scope of the present invention. Each of these embodiments and obvious variations thereof is contemplated as falling within the spirit and scope of the claimed invention.

WHAT IS CLAIMED IS:

1. The combination of a dental implant and an abutment, said implant for integrating with living jawbone and including a boss protruding away from an upper portion thereof for engaging said abutment and a threaded bore, said abutment comprising:

a first part having an upper end, a lower end, a central axis, and a bore extending therethough along said central axis, said first part having adjacent to said lower end a socket for receiving said boss of said implant, a portion of said bore being defined by a surface that tapers inwardly toward said central axis in a direction toward said lower end at a predetermined angle; and

an elongated second part for extending through said bore of said first part, said second part including a threaded portion for engaging said threaded bore of said implant and a post protruding above said upper end of said first part, said second part including an outer surface with a tapered portion that tapers at an angle substantially the same as said predetermined angle, said tapered portion engaging said surface of said first part.

2. The combination of claim 1, wherein said first part includes a shoulder facing away from said implant.

3. The combination of claim 2, wherein said shoulder separates first and second regions of said first part, said first region adjacent said implant and flaring outwardly from said central axis in a direction away from said first end, said second region flaring inwardly toward said central axis in a direction toward said second end.

4. The combination of claim 1, wherein said predetermined angle is in the range from about 5° to about 20°.

5. The combination of claim 1, wherein said post includes a threaded hole for receiving a screw to attach a component onto said second part.

6. The combination of claim 1, wherein said post includes a flat surface for non-rotationally engaging components attached on said second part.

7. The combination of claim 1, wherein said socket and said boss provide for non-rotational engagement.

8. The combination of claim 1, wherein said socket includes anti-rotational structure to resist the turning of said first part on said implant.

9. The combination of claim 8, wherein said anti-rotational structure includes a shim-like structure.

10. The combination of claim 8, wherein said anti-rotational structure includes a block-like structure.

11. The combination of claim 1, wherein said first part has an exterior surface with a portion thereof being non-round.

12. The combination of claim 1, wherein said post protrudes above said first part by a distance that is larger than the height of said first part.

13. The combination of claim 1, wherein said post protrudes above said first part by a distance that is at least as large as approximately the length of said second part below said upper end of said first part.

14. The combination of claim 1, wherein said threaded portion is a threaded stem integral with said second part.

15. An abutment for attaching to a dental implant embedded in living jawbone and having a fitting at its upper end, said abutment comprising:

a first part having an upper end, a lower end, a central axis, and a bore extending therethough along said central axis, said first part having adjacent to said lower end a interlocking fitting for mating with said fitting of said implant, said bore being defined in part by a surface that tapers inwardly toward said central axis in the direction of said lower end at a predetermined angle; and

an elongated second part for extending through said bore of said first part, said second part including a threaded portion for engaging said threaded bore of said implant and a post protruding above said upper end of said first part, said second part including an outer surface with a tapered portion that tapers at an angle substantially the same as said predetermined angle, said tapered portion lockingly engaging said surface of said first part.

16. The abutment of claim 15, wherein said post includes a threaded hole for receiving a screw to attach a component onto said second part.

17. The abutment of claim 15, wherein said post includes a flat surface for non-rotationally engaging components attached on said second part.

18. The abutment of claim 15, wherein said socket includes anti-rotational structure to resist the turning of said first part on said implant.

19. The abutment of claim 15, wherein said first part has an exterior surface with a portion thereof being non-round.

20. The abutment of claim 15, wherein said threaded portion is a threaded stem integral with said second part.

21. The abutment of claim 15, wherein said interlocking fitting of said first part provides non-rotational engagement with said fitting of said implant.

22. The abutment of claim 15, further including an impression coping fitting over said post and being attached thereon by a screw engaging said threaded hole in said post.

23. The abutment of claim 15, further including a healing cap fitting over said post and being attached thereon by a screw engaging said threaded hole in said post.

24. The abutment of claim 15, further including a cylinder fitting over said post and being attached thereon by a screw engaging said threaded hole in said post, said cylinder for holding a permanent dentition.

25. The abutment of claim 15, further including an artificial tooth attached on said post.

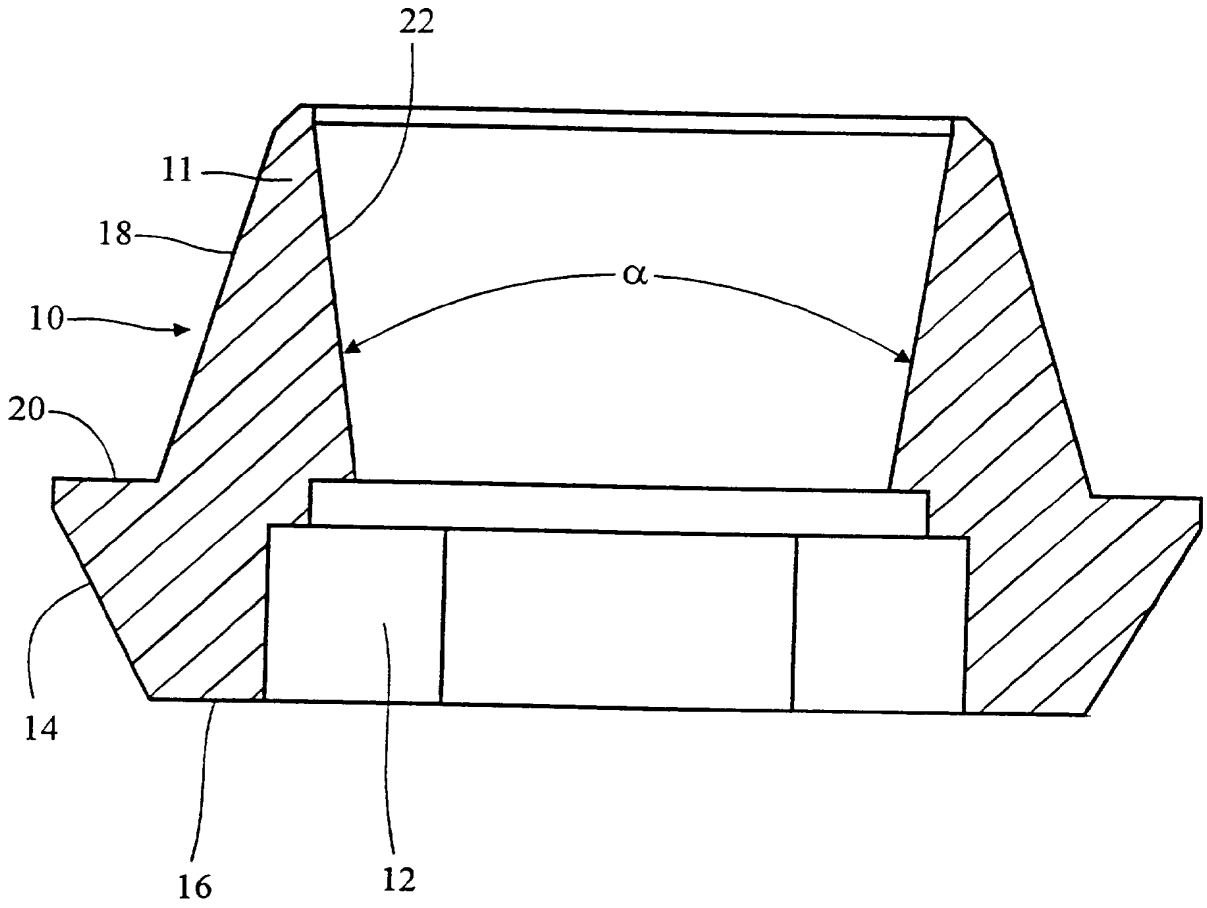


Fig. 1

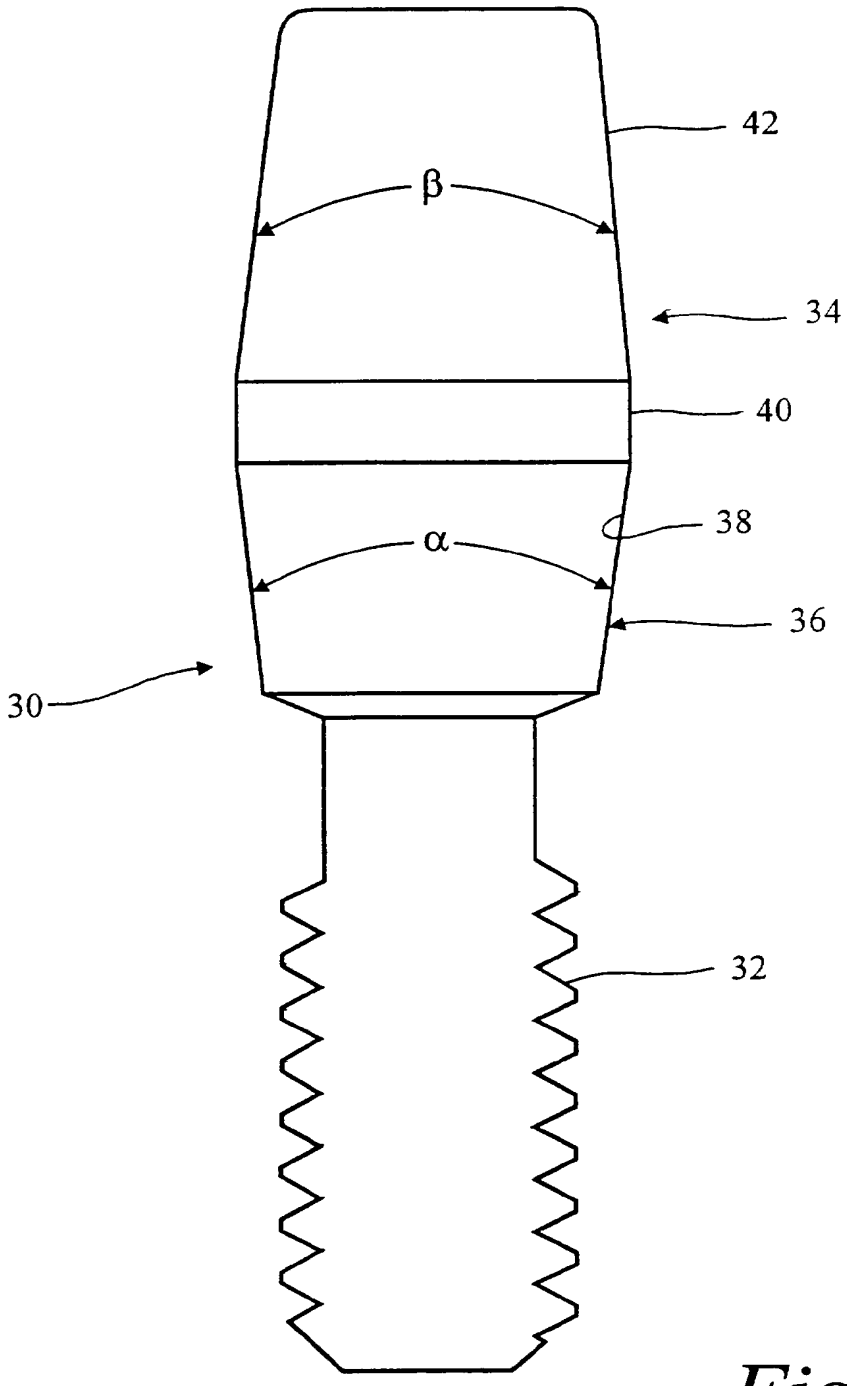


Fig. 2

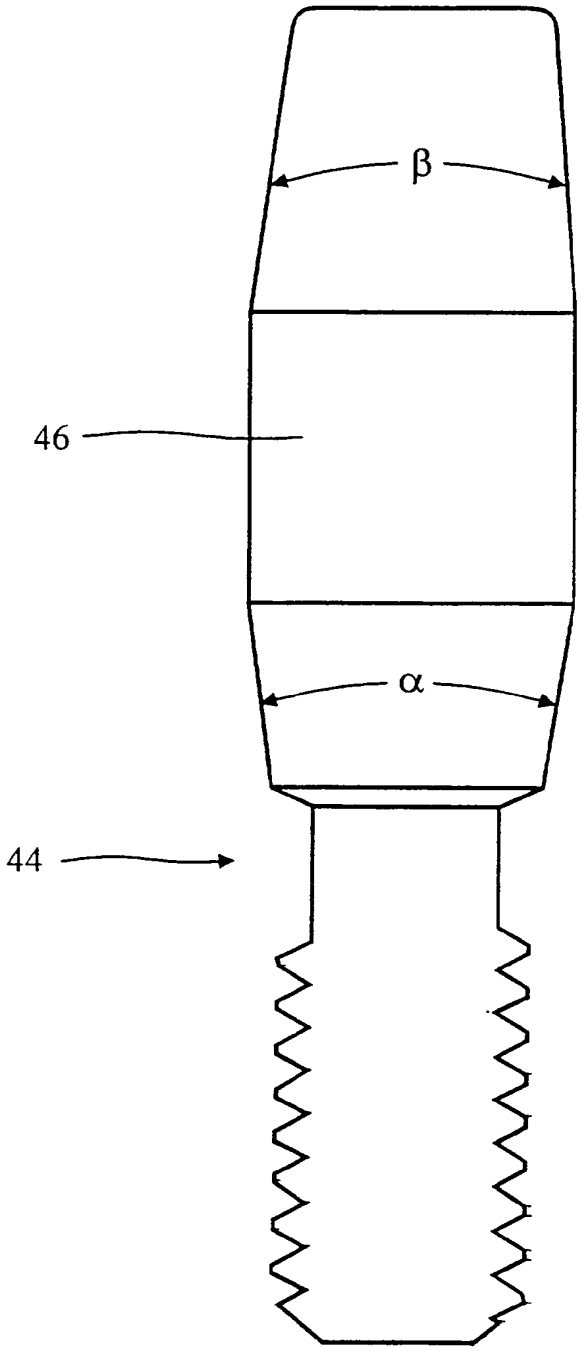


Fig. 3

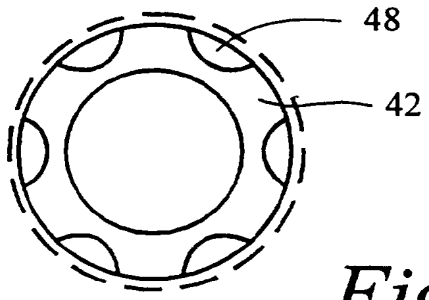


Fig. 5

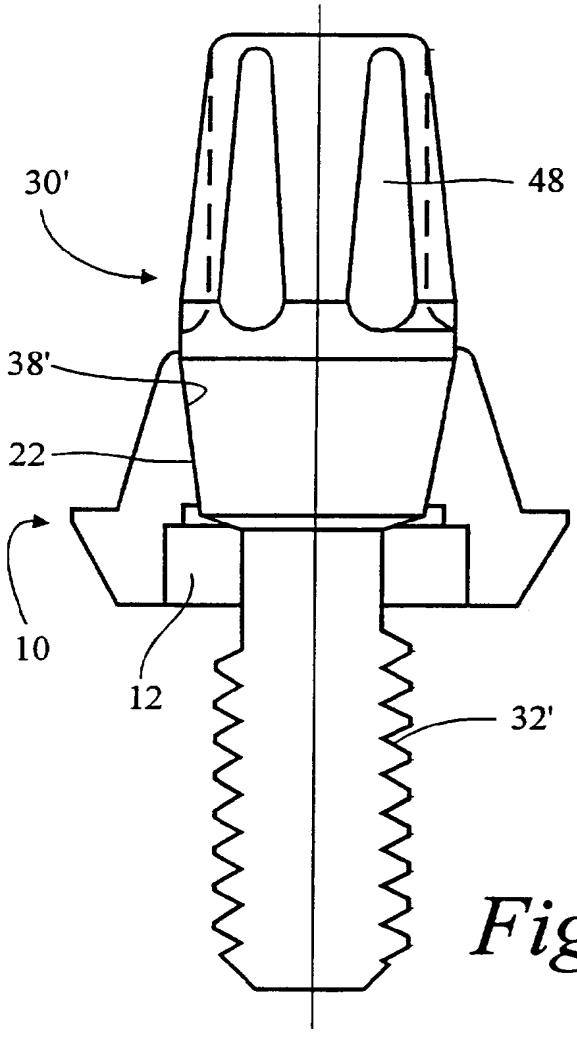


Fig. 4

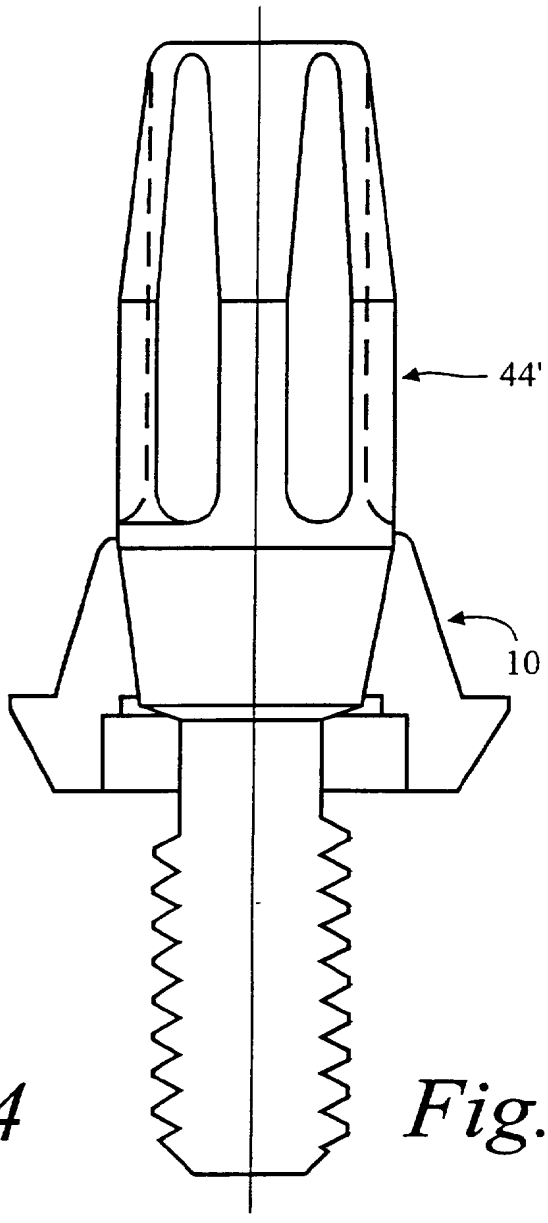


Fig. 6

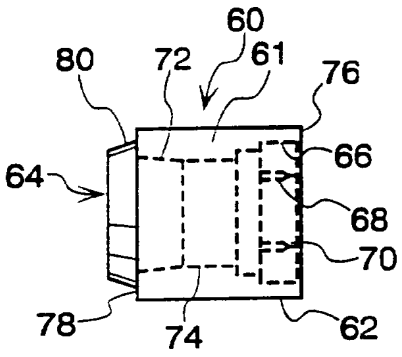


Fig. 7A

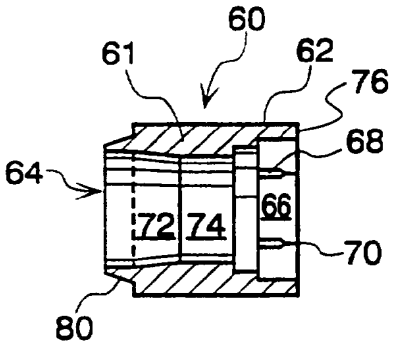


Fig. 7B

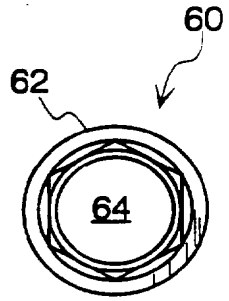


Fig. 7C

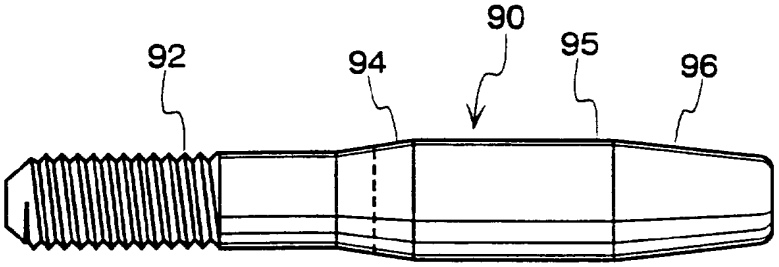


Fig. 8A

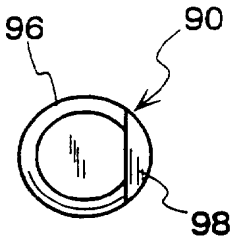


Fig. 8B

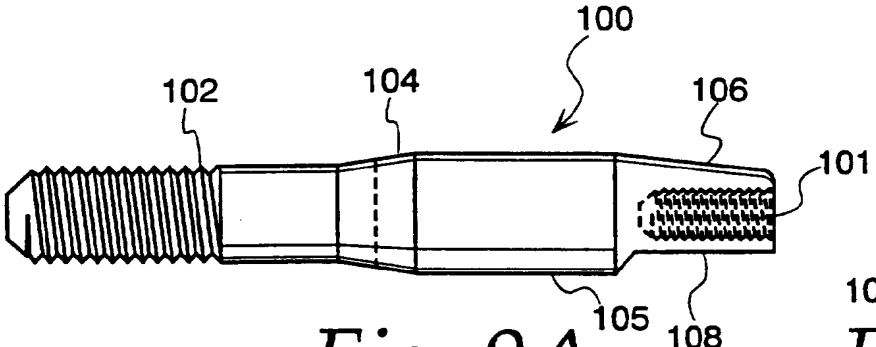


Fig. 9A

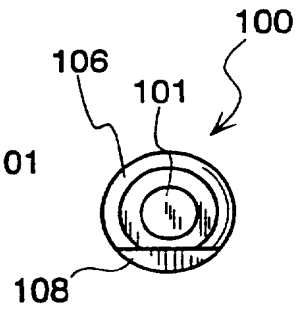


Fig. 9B

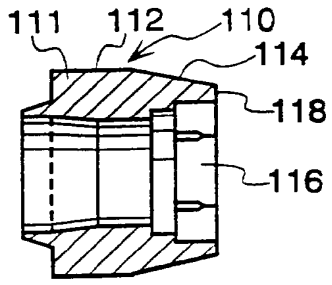


Fig. 10A

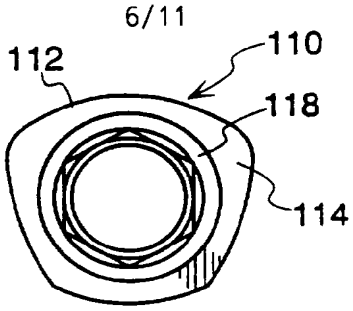


Fig. 10B

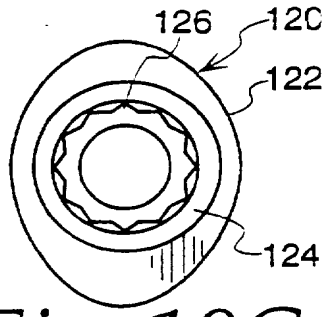


Fig. 10C

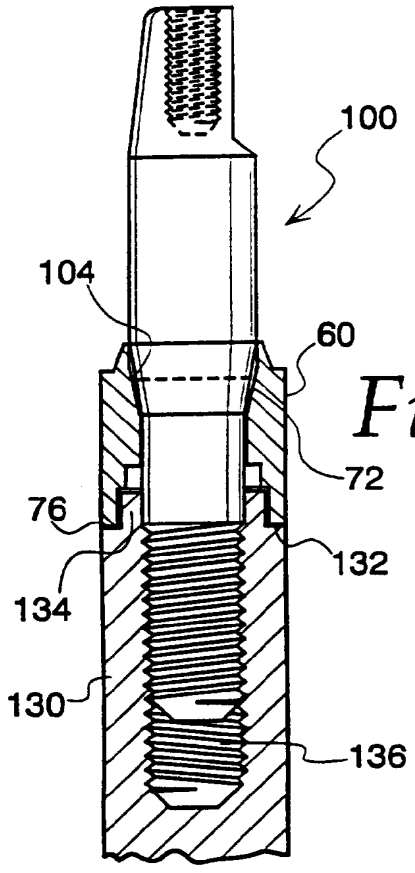
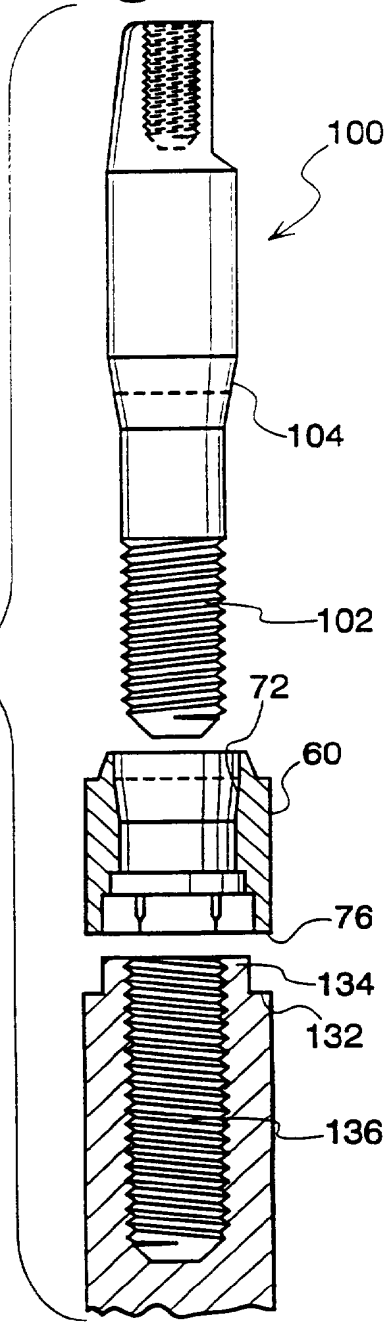


Fig. 11a

Fig. 11b



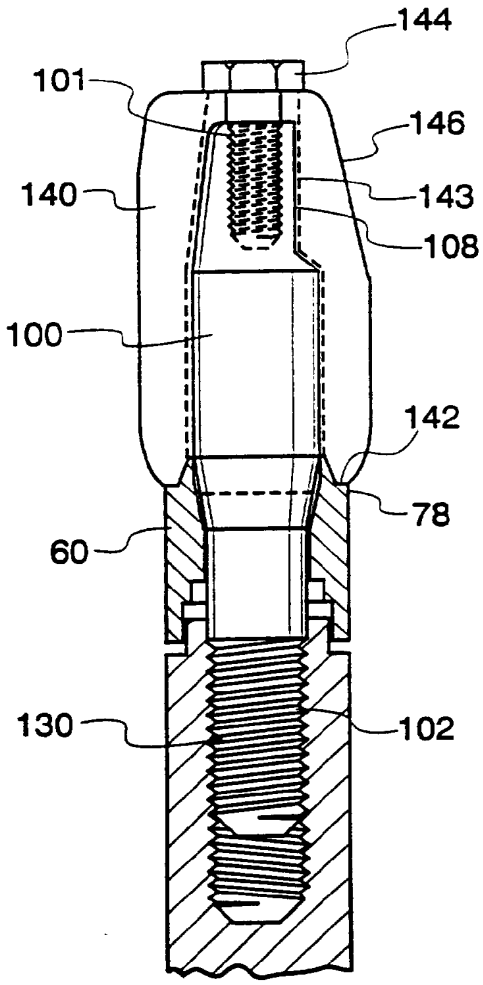

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Fig. 12

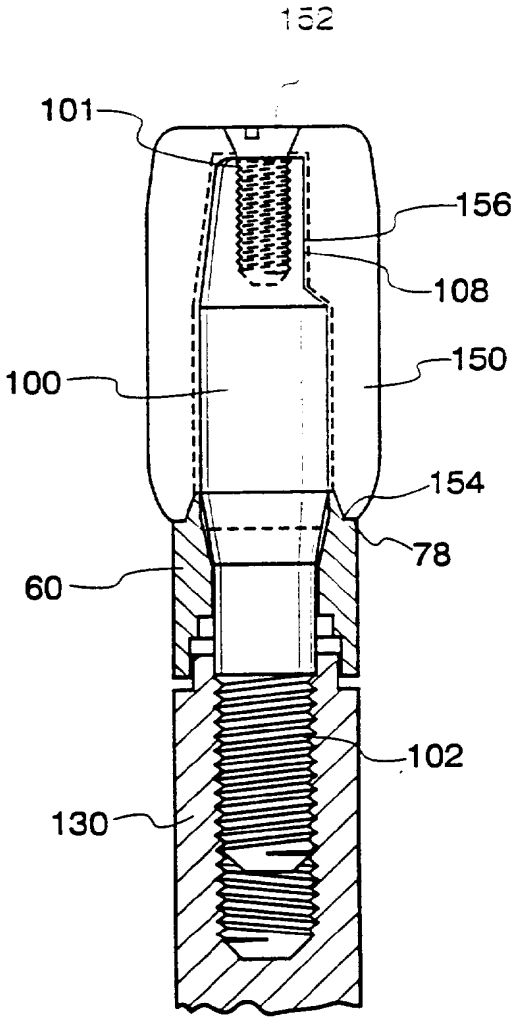
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Fig. 13

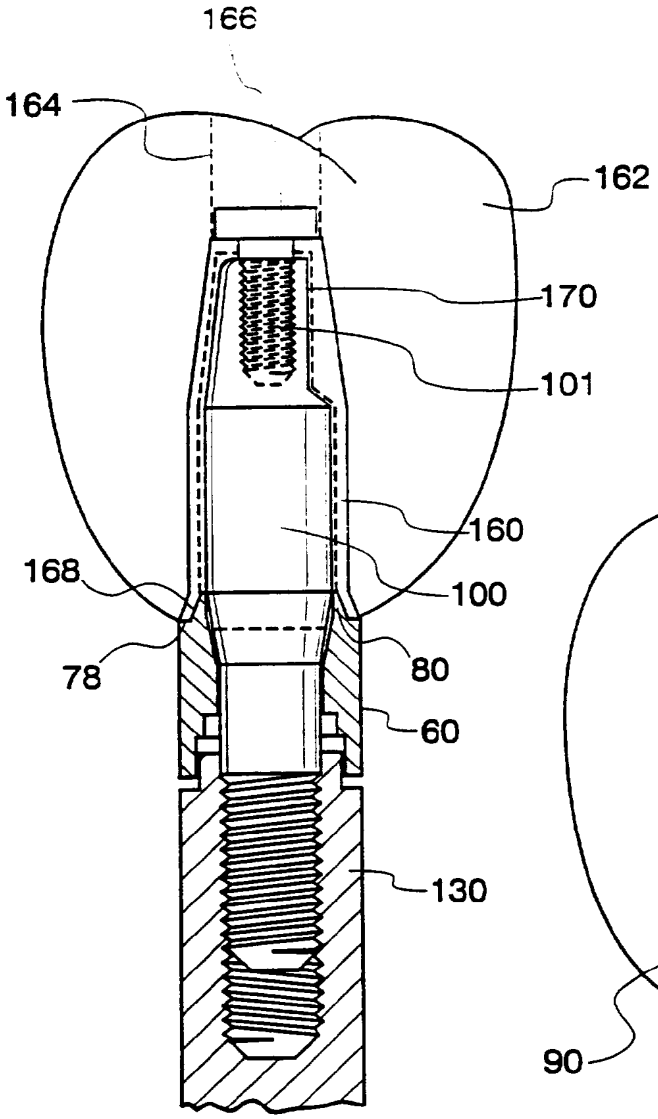

Fig. 14

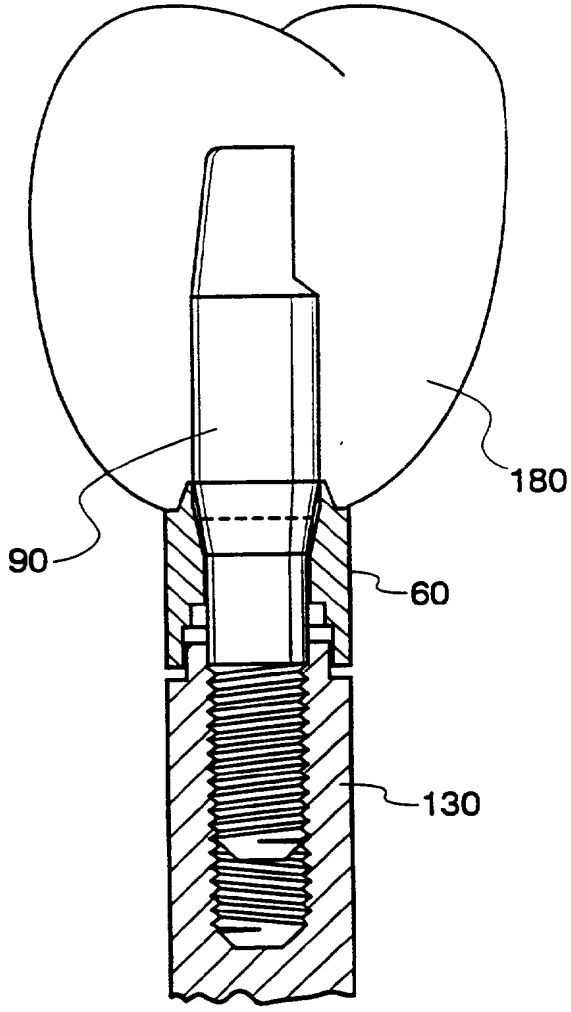

Fig. 15

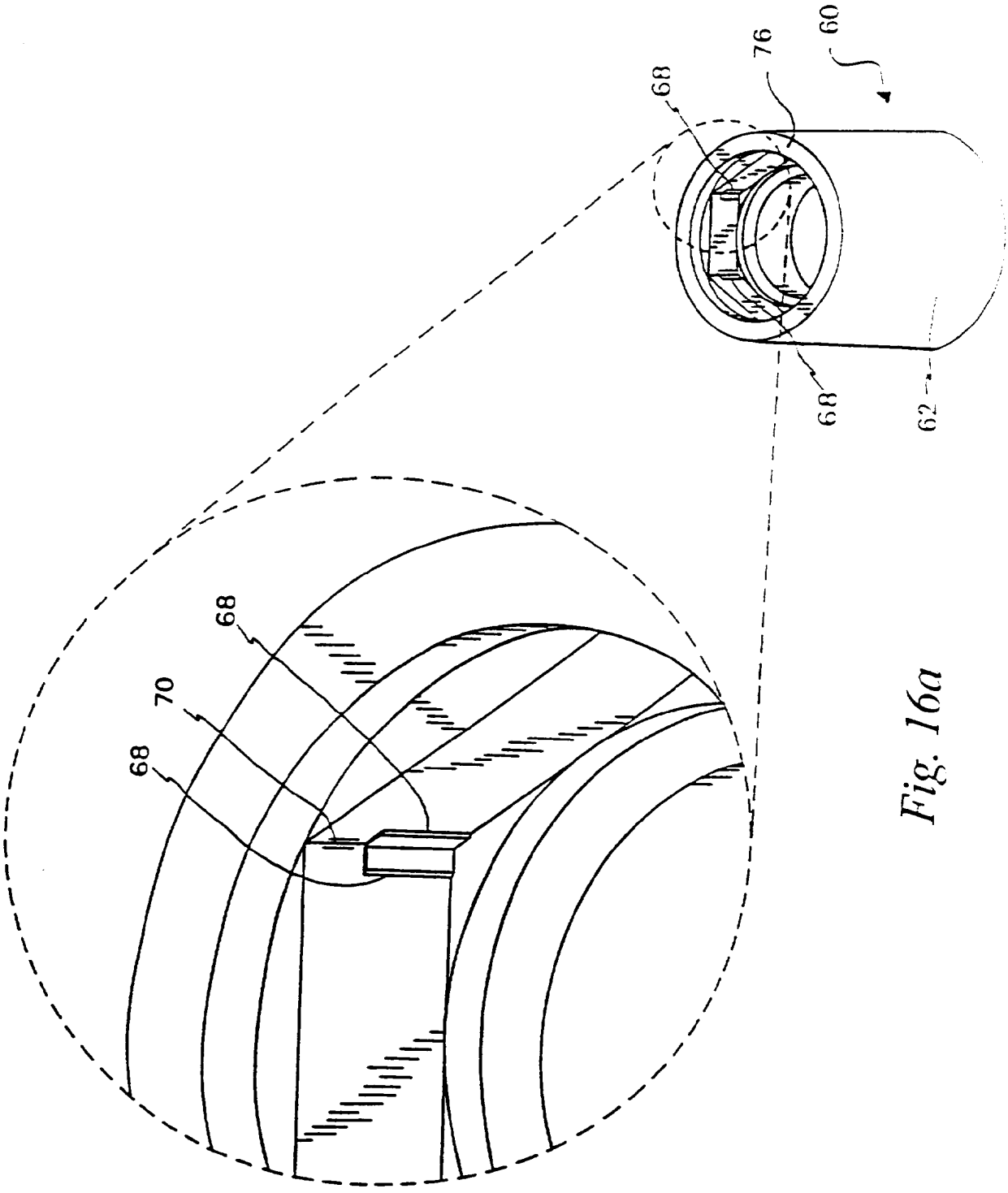

Fig. 16a

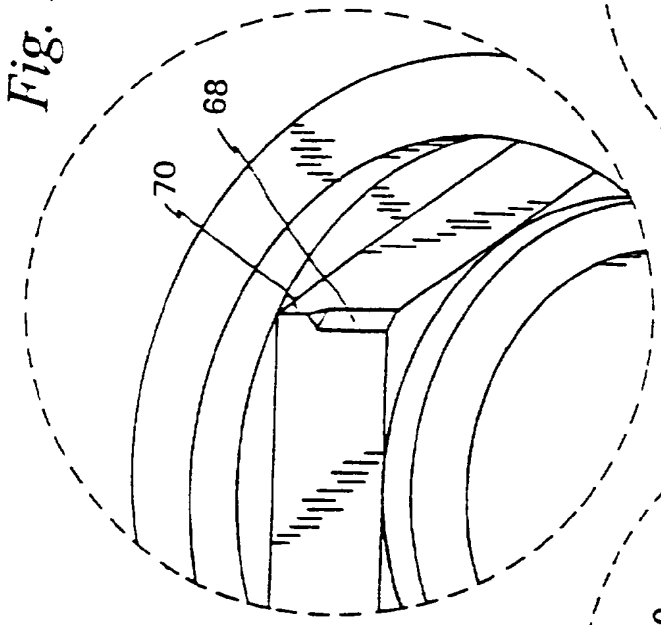

Fig. 16c

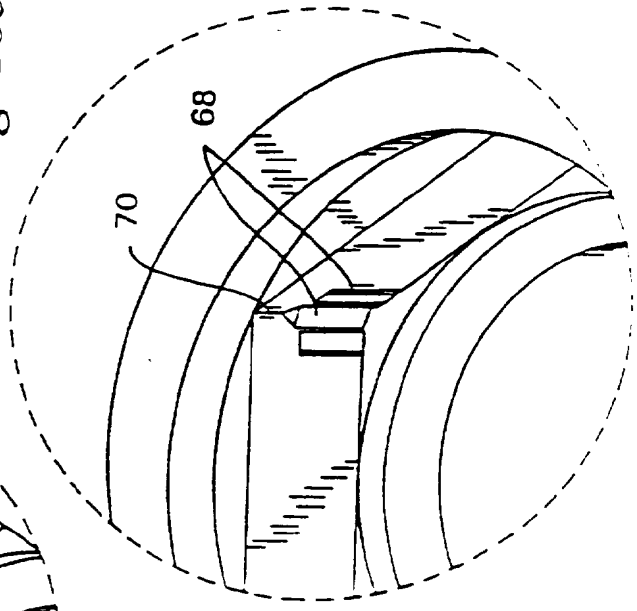

Fig. 16e

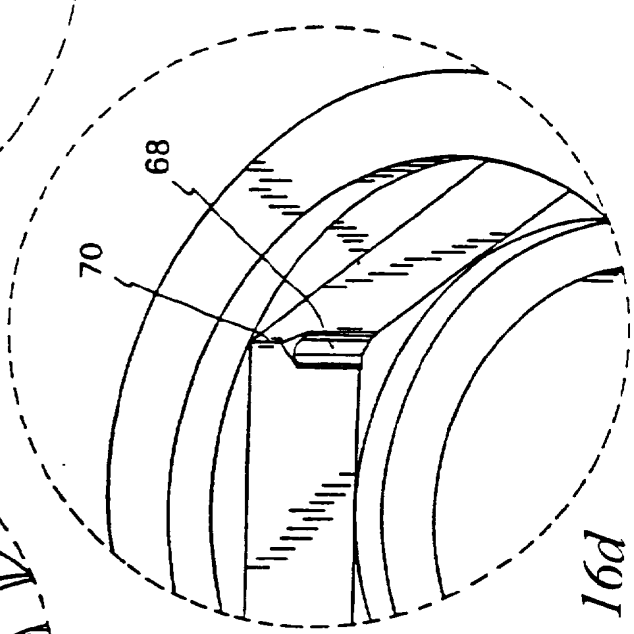

Fig. 16d

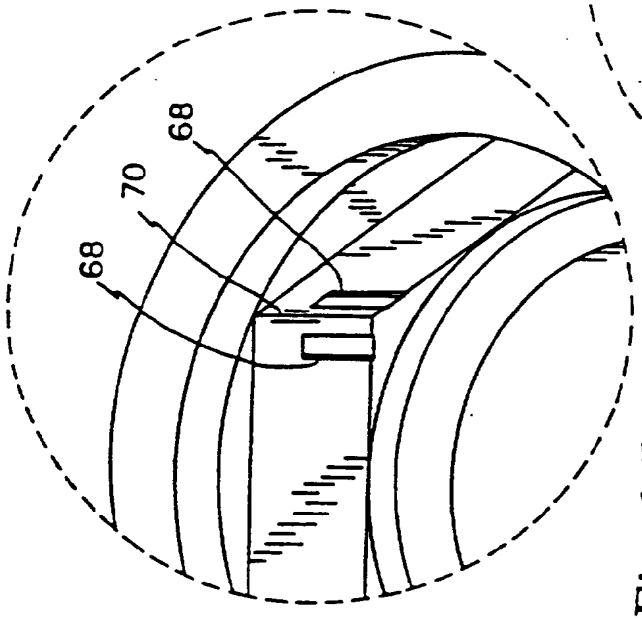

Fig. 16b

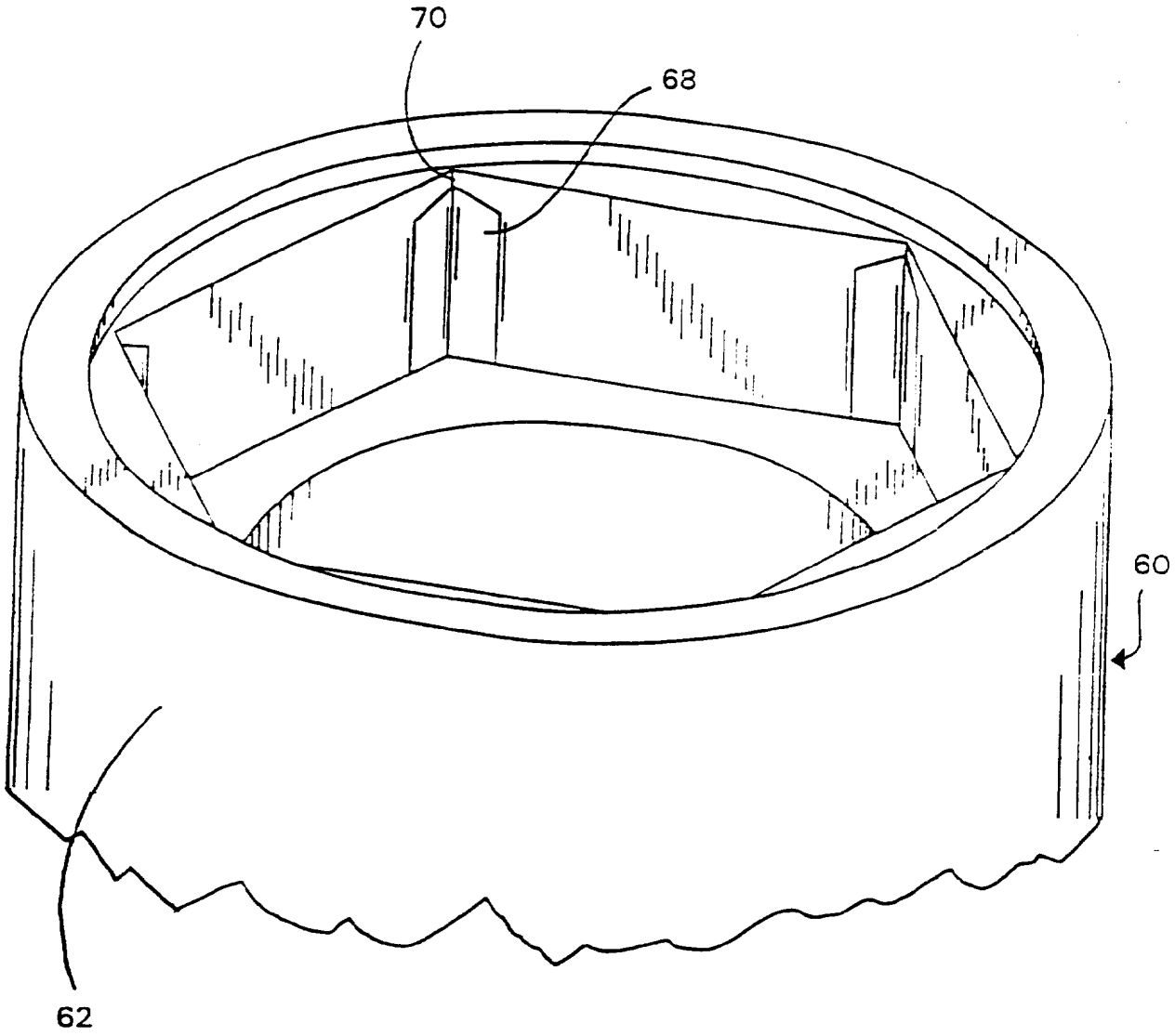

Fig. 16f

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/16550

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61C 8/00
US CL :433/173

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 433/172-175

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,872,839 A (BRAJNOVIC) 10 October 1989, col. 2, line 35 to col. 4, line 15.	1, 2, 6, 11, 14, 15, 19, 20 --- 3, 4, 7-10, 12, 13, 17, 18, 21-25
X --- Y	US, 4,988,297 A (LAZZARA et al) 29 January 1991, col.3, lines 25-56.	1, 2, 5, 7, 8, 11 14-16, 18-21 --- 4, 6, 9, 10, 12, 13, 17, 22-25

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
11 FEBRUARY 1997

Date of mailing of the international search report
04 MAR 1997

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Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/16550

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,104,318 A (PICHE et al) 14 April 1992, col. 2, line 35 to col. 4, line 35.	1-3, 5-8, 11, 14-21, 25 ---------- 4, 9, 10, 12, 13, 22-24
Y	US 5,344,457 (PILLIAR et al) 06 September 1994, col. 4, line 65 to col. 8, line 60.	1-25